BrainGate - A Computer Innovation for Patients with Paralysis

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ABSTRACT

The BrainGate brain implant system, created and formerly owned by Cyberkinetics, is presently being developed and is undergoing clinical testing. It is intended to assist people who have lost control over their limbs or other physiological functions, such as individuals who have ALS or spinal cord injuries. Braingate, Co., a privately held company, currently owns the Braingate technology and associated Cyberkinetic assets[1]. The sensor, which is inserted into the patient's brain, tracks brain activity while translating the user's intentions into orders for the computer.

The brain's cortex has an electrode chip called a "brain gate." It is a system that was created in 2003 by the neurology department at Brown University and the biotech business cyberkinetics[2]. The electrical impulses between the brain and the electrical devices are exchanged to aid. The idea behind this brain implant system is that when the brain is functioning normally, signals are produced that can't be delivered to the arms, hands, or legs are interpreted and converted into cursor movements, allowing the user to control the computer with their thoughts. All signalling procedures are carried out by specialised software[3].

INTRODUCTION

Researchers from Brown University's Department of Neuroscience and the biotech firm Cyberkinetics, Inc. created the initial version of BrainGate. Afterwards, Cyberkinetics sold off the device production to Blackrock Microsystems, which currently produces the sensors and the electronics for data gathering[1]. The BrainGate Corporation acquired the technology and associated intellectual property from Cyberkinetics and is still the owner of the intellectual property associated with BrainGate[2].

A sensor implanted in the brain and an external decoder device that is connected to a prosthesis or other external item make up the BrainGate system.The device was created to assist those who are unable to control their limbs or other bodily functions[3].Presently, the device uses 100 very tiny electrodes to detect neural activity in a particular region of the brain. For instance, the part that controls arm movement is interpreted electically. Two patients have received the Brain Gate implant, according to the Cyber Kinetics website[4]. The Neural Prosthetics Translational Laboratory at Stanford University researchers joined the experiment as a second location in November 2011.The potential to enhance human interaction, communication, and way of life is going to soar[5].

Imagine a time when warriors will only be able to interact with one another by thinking, when people will be able to sight in the UV and IR range of the electromagnetic spectrum, or when they will be able to hear speech on an aircraft carrier's loud flight deck[6]. Imagine a future in which battle fighters act on thoughts rather than their own, as if the human brain had its own wireless modem. Think about the possibility that we'll one day be able to download enormous amounts of knowledge right into our brains! to avoid having to learn everything from start, which takes a long time. We could pay to have a "knowledge implant" instead of paying to attend college and could be able to learn as much as we would learn in a lifetime's worth of information and competence in many different professions at a young age[7].

Robotics and artificial intelligence are unavoidable topics when discussing high-end computers and intelligent interfaces. The majority of equipment will soon be rationally or remotely operated. Researchers are close to making advances in brain interfaces, which means we could soon be able to integrate robots into our thoughts. This technology has the potential to change our lives in ways that were previously only imagined in science fiction films[8].

Formerly, it was only possible in science fiction to use thinking to control a robotic device, wheelchair, prosthetic limb, or computer.

HARDWARE COMPONENTS AND SOFTWARE TOOLS

The development of BrainGate a game-changing technology and device that gives renewed hope to paraplegics, quadriplegics, and others suffering from spinal cord injuries and strokes, is the result of years of advanced research by world-renowned experts at prestigious universities, including Brown, Harvard, Emory, MIT, Columbia, and the University of Utah. It might ultimately change how all of our brains function[9].

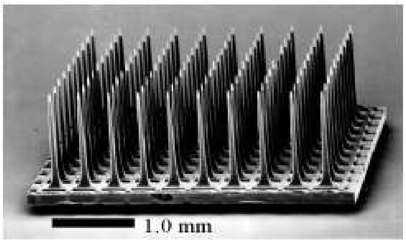
RESEARCH ON BRAINGATE ON ANIMALS

BCI were originally inserted into rats. Rat cerebral cortex signals were captured to control the BCI and cause the movement.

Researchers at Pittsburgh University conducted an experiment on a monkey and discovered that the animal can help itself to food by sending brain impulses to a robotic arm. It had been a success since the monkey could now operate a computer cursor on the display using only his mind. Once it was discovered that the animal trials had gone well, human trials were begun.

By simple mental commands and no physical output, monkeys have been able to control robotic arms and move computer cursors on-screen. Cats' visual signals have been deciphered in other studies.

The Chip: It is a 4-millimeter square silicon chip inserted in the primary motor cortex, the part of the brain in charge of coordinating movement. It is studded with 100 hair-thin microelectrodes and is made of silicon.



The Connector:The impulses are transferred through the pedestal plug that is connected to the skull in different directions depending on how the user thinks about moving the cursor up or down.

The Converter: The signal is sent to an amplifier the size of a shoebox installed on the wheelchair of the user. Here, it is transformed into optical data and sent via fiber-optic cable to a computer.

The Computer: The special decoding software translates brain activity for the computer. It produces an output for communication.

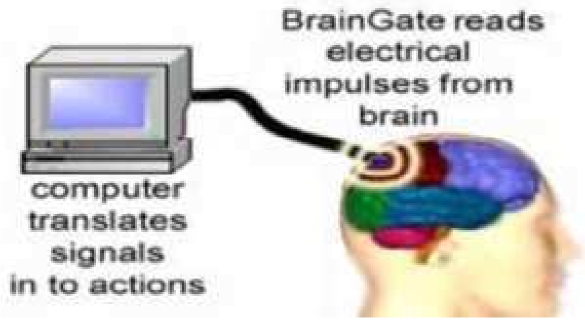
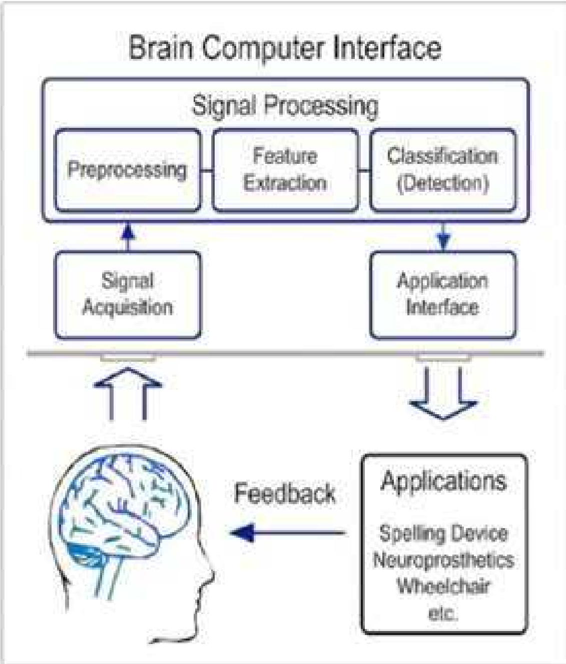


Fig. Computer and BrainGate Interaction

WORKING OF BRAINGATE

BLOCK DIAGRAM OF A GENERAL BRAIN-COMPUTER INTERFACE



The BMI is made up of numerous parts, including: The implant device is a microelectrode array that is inserted into the frontal and parietal lobes of the brain, which are responsible for providing various output commands that regulate intricate muscle movements. This gadget records the activity potentials of individual neurons and then uses a rate coding to describe the neural output. Spike detection algorithms, neural encoding and decoding systems, data acquisition and real-time processing systems, etc. are all included in the signal recording and processing section. For this, a high performance dsp architecture is employed.Feedback has the power to accelerate learning and enhance performance.

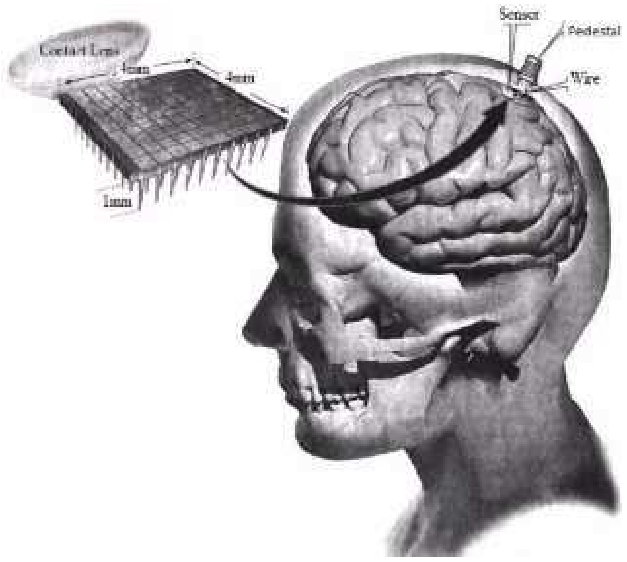


Fig: A silicon chip implanted in the brain cortex through pedestal

Electrodes on the silicon chip implanted in the person's brain detect neural activity from a variety of neural impulses in the motor cortex when the person thinks about moving the computer cursor. Via connecting cables, the impulses are sent from the chip to a pedestal that protrudes from the head. The pedestal sends the signal to an amplifier after filtering out any unwanted signals or noise. A fibre optic cable is used to transfer the signal from the acquisition equipment to the computer. The signal is subsequently converted into an action by the computer, which moves the cursor.

A neuromotor prosthetic device called the braingate system is made up of an array of one hundred silicon microelectrodes, each measuring 1 millimetre in length and being one millimetre thinner than a human hair. The array's electrodes are spaced less than half a millimetre apart, and a 13 cm ribbon cable that connects it to a computer is connected.

CONCLUSION

A proprietary, experimental Brain-Computer Interface (BCI) called the BrainGate neural interface system comprises of an inside sensor to detect brain cell activity and external processors to translate these brain signals into a computer-mediated output that the user may control.

The motor cortex, a region of the brain in charge of voluntary movement, has the sensor implanted on its surface. The electrodes insert into the surface of the brain for approximately 1mm, where they take up electrical impulses from adjacent neurons known as neural spiking, the language of the brain, and send them through tiny gold wires to a titanium pedestal that sticks out about an inch above the patient's scalp. The pedestal is connected to computers, signal processors, and displays through an external connection. The technology can simultaneously detect the electrical activity of a large number of individual neurons. Data is sent from the brain's neurons to computers for analysis, and then thoughts are utilised to operate an external object.The neurons that make up our brains are small, distinct nerve cells that are linked to one another by dendrites and axons. Our neurons are active whenever we think, act, feel, or remember something. Small electric signals that travel from neuron to neuron at speeds of up to 250 mph do that work. Differential electric potentials carried by ions on each neuron's membrane are what cause the messages to be sent. It may be possible for scientists to ascertain what signals are sent from the optic nerve to the brain when someone perceives the colour red. They might build a camera that, upon detecting red, would send the correct impulses to the brain, allowing a person to "see" without the need of their eyes.

The development of Braingate has completely changed the medical industry. The amazing development gives hope that one day paralysed people will be able to operate wheelchairs, computers, and artificial limbs on their own.

This progress in brain-machine interface technology has a wide range of possible applications, including the creation of human enhancement for both military and commercial uses. The main objective of this technology and gadgets like the brain gate is to assist people who are paralysed in carrying out daily tasks that are essential to a normal human existence. For people with Alzheimer's disease, epilepsy, or strokes, the brain gate can take the position of the memory centre.

The "BrainGate" device can give paralysed or motor-impaired people a means of communication by converting thinking into direct computer control. Regular people may also be able to use BrainGate technology to enhance their interaction with the digital world if they are prepared for the implant.

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